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2. Existing Document Number/Revision 5-21000-OPS-GT.6/Rev.2			1. Date 5/6/94		25. DMR. No. 94-DMR-000994 <i>5/6/94</i>	
4. Originator's Name/Phone/Page/Location D. Yashan/3692/D1388/7893A			3. New Document Number or Document Number if it is to be changed with this Revision N/A			
6. Document Type <input checked="" type="checkbox"/> Procedure <input type="checkbox"/> Other			7. Document Modification Type (Check only one) <input type="checkbox"/> New <input type="checkbox"/> Revision <input checked="" type="checkbox"/> Intent Change <input type="checkbox"/> Nonintent Change <input type="checkbox"/> Editorial Correction <input type="checkbox"/> Cancellation			
8. Item	9. Page	10. Step	11. Proposed Modifications			
LIMITED SCOPE: This DMR is limited to the Dam Upgrades Project.						
1	3B of 18	Section 6.0	To the first sentence after "...and open-pipe piezometers (observation wells)...", add the following: ", other types of piezometers, and inclinometers".			
2	4-5 of 18	Section 5.1 <i>RR 5/20/94</i>	Delete bullets 2, 3, 4, 5, and 6. Change bullet 9 to "RFP potable water". Change bullet 10 to "Drums for containment of cuttings, if necessary".			
3	5 of 18	Section 5.2 <i>RR 5/20/94</i>	Change last sentence of 1st paragraph to read: "Downhole equipment will be decontaminated in accordance with SOP FO.4, (Heavy Equipment Decontamination) upon completion of work in a work area."			
4	9A of 18	Section 5.3.1.6 <i>RR 5/20/94</i>	Add Section 5.3.1.6, Inclinometer Casing, as follows: "Inclinometer casing will consist of new, flush-joint acrylonitriles butadiene styrene (ABS) unless another type of casing is required by the FSP or project-specific workplan. The inclinometer casing will extend to approximately 2 feet above the ground surface. The bottom of the casing will be fitted with a slip-in cap that will be glued and riveted in place. The top of the casing will be fitted with a slip-in cap which can be easily removed by hand. All joints in the casing string will be glued and riveted and covered with duct tape in order to support lower sections of casing during installation and to prevent inflow of cement grout. Orientation of the inclinometer casing will be such that the grooves inside the casing will allow for proper placement of the inclinometer probes, i.e., one set of two grooves are parallel to the anticipated direction of movement and one set of two grooves are perpendicular to the anticipated direction of movement."			
5	9A of 18	Section 5.3.1.7 <i>RR 5/20/94</i>	Add Section 5.3.1.7, Cement Grout, as follows: "The annular space between the casing and borehole will be grouted from the bottom of the casing to ground surface. The grout will consist of Portland cement and high-solids reduced pH bentonite grout mixed in a powered mechanical mixer. The grout will be proportioned so that its strength is approximately the same as the surrounding material. Grout will be placed outside of the inclinometer casing using a side discharge tremie pipe located at the bottom of the casing or with a grout cap/plug assembly that allows for pumping of grout through the inclinometer approximately 2 feet below ground surface."			
12. Justification (Reason for Modification, EJO#, TP#, etc.)						
All changes, additions, and deletions are necessary to provide relevance of this SOP to geotechnical drilling, piezometer installation, and inclinometer installation.						
If modification is for a new procedure or a revision, list concurring disciplines in Block 13, and enter N/A in Blocks 14 and 15. If modification is for any type of change or a cancellation, organizations are listed in Block 13, then Concurror prints, and signs in Block 14, and dates in Block 15.						
13. Organization		14. Print and Sign (if applicable)			15. Date (if applicable)	
SME		Rob Smith <i>Rob Smith</i>			5/24/94	
EQS		Mark Brook <i>RR Mark L. Brook</i>			5-24-94	
16. Originator's Supervisor (print/sign/date)		S. Marshall <i>Rob Brown for S.A. Marshall</i>				
17. Assigned SME/Phone/Page/Location		18. Cost Center	19. Charge Number	20. Requested Completion Date	21. Effective Date	
Rob Smith/8705/5135/080-643		0202	ENV-GT	5/23/94	6-7-94 <i>RR</i>	
22. Accelerated Review? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>		23. ORC Review ORC Review Not Required; This Nonintent Change is being processed as an Intent Change to expedite the DMR process.				
24. Responsible Manager (print, sign, date)		Steve Singer <i>Stephen H. Singer</i> <i>Stephen H. Singer</i> 5/24/94				

REVIEWED FOR CLASSIFICATION/UCNT

BY NA
DATE NADOCUMENT CLASSIFICATION REVIEW WAIVER
PER R.B. HOFFMAN, CLASSIFICATION OFFICE
JUNE 11, 1991

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2. or 3. Document Number/Revision

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3. Document Title

Monitoring Wells and Piezometer Installation

8. Item	9. Page	10. Step	11. Proposed Modifications
6	15D of 18	Section 6.3.2.4	<p>Add Section 6.3.2.4, Inclinator Features, as follows: "A protective steel casing with hinged and locking cap and appropriate dimensions will be installed over the inclinometer casing at such a time as to maximize total productivity and minimize the possibility of damage to the casing. The protective casing will have the inclinometer designation welded on the side. The bottom of the casing will be embedded 2 to 3 feet below the ground surface in concrete. The annulus between the inclinometer casing and the protective casing will be filled with concrete to a minimum of 12 inches above the ground surface, and a 1/4-inch diameter hole will be drilled in the protective casing just above the concrete surface to allow for drainage.</p> <p>At the same time the protective steel casing is concreted in place, an external concrete collar approximately 3 foot square will be placed around the protective casing at the ground surface. The collar will be graded to slope away from the casing in all directions, and will have the inclinometer designation inscribed in it before the concrete sets. If traffic or vegetation conditions warrant extra protection, four 3-inch-diameter steel posts will be installed radially from the inclinometer casing at a distance of approximately 4 feet. The posts will be filled with sand or concrete and embedded in concrete 3 feet below ground surface with a minimum of 3 feet sticking up above ground surface. If the post is filled with sand, the top 3 to 6 inches will be filled with concrete to prohibit water from entering the post."</p>
7	16-17 of 18	Section 7.0	<p>Change first three sentences of the 2nd paragraph to read as follows: "The installation of piezometers and inclinometers will be documented on appropriate report forms. As a minimum, the following information, if applicable, will be documented on these forms."</p>

12. Justification (Reason for Modification, EJO#, TP#, etc.)

All changes, additions, and deletions are necessary to provide relevance of this SOP to geotechnical drilling, piezometer installation, and inclinometer installation.

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9	09/23/93	DCN 93.06
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5.1.3 Submit WIN form and apply for Soil Disturbance Permit fo RFP Construction Management.

5.1.4 Receive approved Soil Disturbance Permit.

5.1.5 Receive notice from Geosciences Division that well permits have been approved by Division of Water Resources and well installation may proceed.

6.0 EQUIPMENT AND PROCEDURES FOR MONITORING WELL AND PIEZOMETER INSTALLATION

Groundwater monitoring wells and open-pipe piezometers (observation wells), other types of piezometers, and inclinometers will be constructed in boreholes drilled and logged according to SOP GT.2, Drilling and Sampling Using Hollow-Stem Auger Techniques, or SOP GT.4, Rotary Drilling and Rock Coring, and SOP GT.1, Logging Alluvial and Bedrock Material. The construction of monitoring wells is the same as that used for piezometers. The distinction between wells and piezometers is based on the intended use. Wells are used for obtaining samples of groundwater while piezometers are intended only for water level measurements. If different types of piezometers are required (e.g., isolated electronic or pneumatic piezometers), they will be addressed in another SOP or in a project-specific work plan. All drilling

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and sampling equipment and materials will be protected from the ground surface with clear plastic sheeting or will be placed on clean drill racks.

Personnel installing monitoring wells need to be cognizant of the many factors influencing the screened intervals selected for wells. For example, water table wells should have screens of sufficient length at the appropriate depth to monitor the water table. Wells with slow recharge should have sufficient screen area to allow adequate sample volume. However, long screened intervals should generally be avoided since they are of limited value for characterizing discrete zones of contamination.

Selection of well screen intervals may also depend on the suspected presence of light or dense immiscible layers of contaminants floating on the water table or residing at the bottom of a hydrostratigraphic unit (HSU). Screened intervals across different HSUs should generally be avoided particularly where there is a potential for cross-contamination between HSUs to occur.

These factors must be addressed during project planning, and the Field Sampling Plan (FSP) will normally provide rationale for the planned sampling. Personnel installing monitoring wells should be familiar with the FSP and the rationale used in determining well screen intervals.

6.1 EQUIPMENT AND MATERIALS

The following is a list of equipment and well materials for well installation:

- Drill rig with appropriately-sized drill bits, augers, and/or rods
- ~~High pressure steamer/sprayer~~
- ~~Sand bailer~~
- ~~Long handled bristle brushes~~
- ~~Wash/rinse tubs~~

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- ~~Phosphate free, lab grade detergent (e.g., Liquinox)~~
- Weighted tape measure
- Water level probe
- ~~Distilled~~ RFP potable water
- Drums for containment of cuttings, if necessary
- Appropriate health and safety equipment
- Field book
- Location map
- Boring log form
- Groundwater observation well report

6.2 DRILLING PROCEDURES

Boreholes for wells will be drilled by using a drill rig and drilling method capable of completing the well to the depth specified in the FSP. All drilling equipment, including the drill rig, water tanks, and all downhole equipment will be decontaminated according to SOP FO.3, General Equipment Decontamination and SOP FO.4, Heavy Equipment Decontamination. Downhole equipment will be decontaminated ~~between boreholes, and other equipment such as the drill rig will be decontaminated between different work areas~~ in accordance with SOP FO.4 (Heavy Equipment Decontamination upon completion of work in a work area.

Before drilling, test borings/wells will have been located, numbered, and identified by using stakes or paint sticks on paved surfaces. Drilling locations will be cleared for buried metal objects and utility interference according to SOP GT.10, Borehole Clearing. Boreholes will be advanced from the ground surface to a predetermined target depth given in the FSP. Boreholes drilled for wells will be logged stratigraphically by examination of the sample cuttings or core samples according to SOP GT.1, Logging Alluvial and Bedrock Material.

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6.3.1.6 Inclinometer Casing

Inclinometer casing will consist of new, flush-joint acrylonitriles butadiene styrene (ABS) unless another type of casing is required by the FSP or project-specific workplan. The inclinometer casing will extend to approximately 2 feet above the ground surface. The bottom of the casing will be fitted with a slip-in cap that will be glued and riveted in place. The top of the casing will be fitted with a slip-in cap which can be easily removed by hand. All joints in the casing string will be glued and riveted and covered with duct tape in order to support lower sections of casing during installation and to prevent inflow of cement grout. Orientation of the inclinometer casing will be such that the grooves inside the casing will allow for proper placement of the inclinometer probes, i.e., one set of two grooves are parallel to the anticipated direction of movement and one set of two grooves are perpendicular to the anticipated direction of movement.

6.3.1.7 Cement Grout

The annular space between the casing and borehole will be grouted from the bottom of the casing to ground surface. The grout will consist of Portland cement and high-solids reduced pH bentonite grout mixed in a powered mechanical mixer. The grout will be proportioned so that its strength is approximately the same as the surrounding material. Grout will be placed outside of the inclinometer casing using a side discharge tremie pipe located at the bottom of the casing or with a grout cap/plug assembly that allows for pumping of grout through the inclinometer approximately 2 feet below ground surface.

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6.3.2.4 Inclinometer Features

A protective steel casing with hinged and locking cap and appropriate dimensions will be installed over the inclinometer casing at such a time as to maximize total productivity and minimize the possibility of damage to the casing. The protective casing will have the inclinometer designation welded on the side. The bottom of the casing will be embedded 2 to 3 feet below the ground surface in concrete. The annulus between the inclinometer casing and the protective casing will be filled with concrete to a minimum of 12 inches above the ground surface, and a 1/4-inch diameter hole will be drilled in the protective casing just above the concrete surface to allow for drainage.

At the same time the protective steel casing is concreted in place, an external concrete collar approximately 3 foot square will be placed around the protective casing at the ground surface. The collar will be graded to slope away from the casing in all directions, and will have the inclinometer designation inscribed in it before the concrete sets. If traffic or vegetation conditions warrant extra protection, four 3-inch-diameter steel posts will be installed radially from the inclinometer casing at a distance of approximately 4 feet. The posts will be filled with sand or concrete and embedded in concrete 3 feet below ground surface with a minimum of 3 feet sticking up above ground surface. If the post is filled with sand, the top 3 to 6 inches will be filled with concrete to prohibit water from entering the post.

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6.4 WELL POINT INSTALLATION

This Section describes the procedures used for installing well points. Before installation, sites will be located, numbered, and identified using stakes (or paint sticks on paved surfaces). Refer to SOP GT.10, Borehole Clearing, for more information regarding clearing the sites of underground obstructions.

After test sites have been located and cleared, an exclusion zone will be established according to the project Health and Safety Plan. The procedure for installing well points at a specific location is as follows:

1. Decontaminate the rig and downhole equipment. See SOP FO.3, General Equipment Decontamination for specific details regarding decontamination.
2. Set up the rig to obtain a thrust direction as close to vertical as possible.
3. Advance threaded expendable point by either hydraulically pushing or hammering to desired depth.
4. At locations within an IHSS, monitor the breathing zone near the rig for volatile organic compounds.
5. Insert the end of the hand-perforated tubing (Polyethylene or Teflon) with a threaded stud attached into the probe rods. Thread this into the expendable drive point. Length of perforated tubing will range between one and five feet based upon magnitude of anticipated water level fluctuations.
6. Hydraulically withdraw probe rods from hole.

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7. Place 10/20 silica sand filter pack to approximately six inches above the top of the screen while keeping tension on the tubing. Place at least six inches of granular bentonite seal above filter pack.
8. Install four-inch long, one-inch diameter PVC casing with threaded or slip cap as protective well-point surface casing. Protective casing will be nearly flush with the ground surface.
9. Install four-foot long, three-inch diameter steel post adjacent to protective casing to act as marker and traffic barrier. Post should be installed such that three feet are above ground.
10. Develop well point with peristaltic or inertia pump. Since these well points are only for measuring water levels, it is not necessary to measure all the parameters referenced in SOP GW.4, Well Development.
11. Survey top protection casing because well-point tubing is too flexible. Refer to SOP GT.17, Land Surveying, for more information regarding site surveying procedures.

7.0 DOCUMENTATION

Provide the WIN form to the Geosciences Division as instructed in 5.1.1. Submit copies of applicable (Sections 5.1.6 and 8.0) records related to this administrative procedure to Geosciences Division.

~~The installation of monitoring wells and piezometers will be documented on groundwater monitoring well and piezometer report forms. Drilling information will be documented on the Rocky Flats Plant Borehole Log form (Form GT.1A) and on the Hollow Stem Auger Drilling form (Form GT.2A), or on the Rotary/Core Drilling form (Form GT.4A). Besides the drilling and~~

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~~borehole information required by these other SOPs, the following documentation will be recorded on the Groundwater Monitoring Well and Piezometer Report Form (Form GT.6A).~~ The installation of piezometers and inclinometers will be documented on appropriate report forms. As a minimum, the following information, if applicable, will be documented on these forms. Location references will use the State Plane Coordinate System and elevations will be in feet above mean sea level (USGS datum). All depth and height measurements will be from ground surface.

- Elevation of ground surface
- Height of top of protective casing
- Height of top of well casing
- Depth of protective casing
- Type and size of protective casing
- Depth of surface seal
- Type of surface seal
- Type and size of well casing
- Type/volume of backfill
- Depth of top of seal
- Type of seal
- Depth of top of filter pack/bottom of seal
- Type/volume of filter pack
- Depth of top of screened section
- Type and size of screened section
- Size of screen openings
- Depth of bottom of screened section
- Depth of bottom of filter pack
- Length of plugged blank section (sump) below screen
- Depth of bottom of plugged blank section (sump)
- Type of backfill below filter pack

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- Diameter of borehole
- Depth of borehole
- Type and depths of centralizers if used
- Generalized stratigraphy and water level summary (based on rig geologist notes)

8.0 ADMINISTRATIVE DOCUMENTATION

The two forms for documenting well completion data and well installation notification for wells (and piezometers) follow the section. The Well Installation Notification Form GT.6A is completed and submitted to the Geosciences Division. Field information documented on the Groundwater Monitoring Well and Piezometer Report Form GT.6B should be entered in electronic data format as specified in SOP FO.14, Field Data Management Form FO.14G. Upon completion of data entry and quality control check, Form GT.6B is delivered to the Operable Unit Project Manager.

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